

Formal syntax and African languages: Dynamic Syntax case studies of Swahili, Bemba, and Hadiyya*

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1. Introduction

Developments in African linguistics and general-theoretical linguistics have for a long time been mutually beneficial. For example, since the 1980s, major contributions to Bantu linguistics have been conducted within the framework of Lexical Functional Grammar, and the development of autosegmental phonology in the 1970s received one of its main impetuses from the tonal phonology of West African languages such as Akan and Igbo. In this paper, I will give a short introduction to the syntactic framework Dynamic Syntax and show its interaction with African linguistics by providing sketches of Dynamic Syntax analyses of agreement with conjoined NPs in Swahili, relative clauses in Bemba, and clause chaining in Hadiyya. Due to the shortness of the paper, no fully worked-out analyses are presented, and my main aim is to show what the model is trying to achieve, and how it might contribute to a better understanding of the syntax of African languages, and the human faculty of language more generally.

2. Historical and conceptual background

Dynamic Syntax aims to provide a formal model of how speakers build semantic representations from lexical and contextual information on a left-to-right basis. The main conceptual claim is that linguistic knowledge is intimately related to humans' ability to parse incoming information and to construct rich semantic representations from fragmentary and underspecified input. Although the model is comparatively recent (Kempson et al. 2001 is the first main introduction), it is embedded in more general developments in theoretical linguistics, and in this section I give a short introduction to the relevant background.

For the purpose of this paper I assume as a starting point two generative premises most clearly formulated in the Chomskyan (1957, 1965, 1995 etc.) tradition, namely that linguistic (or at least syntactic) knowledge is recursive and can be explicitly characterised in a formal model, and that linguistic (or at least syntactic) knowledge is a mental/cognitive entity involving mental representations. This means that a model of linguistic knowledge needs more than just memory, as humans are capable of understanding and producing a variety of sentences which they have never encountered before, and to use language in ever new and changing contexts and circumstances. It also means that a model of explanation needs to be formal, that is, explicit about what forms of representations, rules, or constraints it employs and how they interact, and how they serve to explain people's actual speech. Finally, the mode of explanation I will

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follow is a cognitive one and assumes that individuals have knowledge of the language(s) they use (even though they are not conscious of it) and that linguistic explanation provides a model of this knowledge – in contrast to those semantic approaches which view language as a system of direct representations of some external reality, but also in contrast to many functional, typological and historical models which view language as a social, or historical, or otherwise independent entity.

However, I will not adopt three further assumptions usually held in generative grammar, namely that 1) linguistic (or at least syntactic) knowledge is encapsulated, i.e. that linguistic/syntactic knowledge is principally different from and unrelated to other cognitive facilities, 2) linguistic (or at least syntactic) knowledge is independent of use, i.e. that competence is essentially different from and independent of performance, and 3) linguistic knowledge is largely context-free and is accessed through grammaticality judgements. The main problem with all of these assumptions is that they are too far removed from what we are trying to explain: It is generally assumed in generative grammar that a model of linguistic knowledge is concerned with competence, that is, the abstract knowledge of languages speakers put to use when speaking. However, it is rarely made precise how exactly this abstract knowledge can be used (see Jackendoff 1997, Gorrell 1995). Furthermore, even though the model is meant to be neutral between speaking and understanding, there is often a bias towards production. For example, when during a derivation a syntactic representation is sent to or mapped into a phonological representation (PF), one is tempted to think of PF aiding in pronunciation, not in parsing. In contrast, Dynamic Syntax assumes a use-based approach to syntax, since the model takes the mental capacity for parsing linguistic input as a starting point, and furthermore acknowledges that contextual, that is, non-syntactic information plays an important role in that process (Marten 2002, Cann et al. 2005).

A second background to Dynamic Syntax is work in formal semantics and Categorical Grammar initiated by Montague (1974; see also Steedman 2000), and Discourse Representation Theory (Kamp and Reyle 1993). Categorical grammar argues that the syntax of natural languages can be analysed in transparent tandem with semantic interpretation just like logical languages are, without a need for semantically unmotivated syntactic rules. Discourse Representation Theory then added to that a conception of levels of mental semantic representations, thus highlighting the difference between natural language and logical languages, while maintaining the insight that natural languages can be interpreted semantically without ‘arbitrary’ syntax.

Finally, work in pragmatics, in particular in Relevance Theory (Sperber and Wilson 1995, Carston 2002) provides a coherent cognitive theory of language use, according to which contextual inference plays a role not only in establishing the implied meaning of an utterance (following Grice 1989), but also in establishing the explicit meaning of an utterance in the first place, thus paving the way for a model in which pragmatic and syntactic knowledge interact. Relevance Theory furthermore argues for the primacy of language understanding: At the heart of our cognitive abilities is the need to process information, not the desire to impart information; and, therefore, language parsing is cognitively more fundamental than language production. This latter point is confirmed by independent work in phonology, where Government Phonology (Kaye 1989) argues that the main role of human phonology is to act as a parsing device, i.e. to divide a

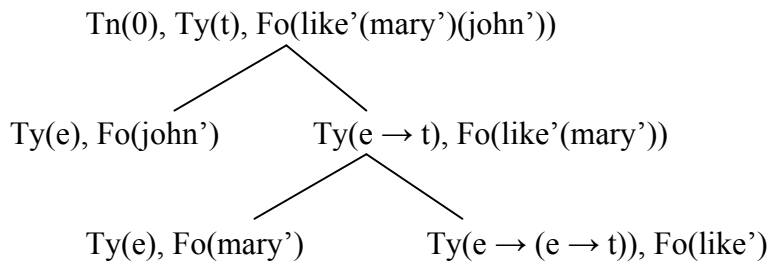
continuous input stream of sound into smaller units, which provide access to lexical information. Thus Dynamic Syntax can be seen as the central piece in comprehension-based model of linguistic knowledge.

Accordingly, in Dynamic Syntax, syntax is seen as a parsing device, contributing to the process from lexical access to the establishment of some interpretation in context (Kempson et al. 2001, Cann et al. 2005). This process is goal-driven, and involves the gradual building of more and more complex semantic representations from lexical input, syntactic rules and pragmatic information, until an appropriate interpretation is derived. Syntactic analysis models the architecture through which hearers establish semantic representations in context, but not necessarily the process itself, that is, the model is still a model of syntactic knowledge, and not a parser, but it assumes that parsing is at the core of this knowledge. In the next section, I will illustrate the formal aspects of the model in more detail.

3. The formal model

The main point of the Dynamic Syntax model is to show the incremental building of semantic representations. These representations are annotated tree structures, which show how the different concepts of a proposition are combined. For example, the proposition associated with the utterance *John likes Mary* can be represented as in (1):

(1) *John likes Mary*



Each node of the tree is annotated with different kinds of information such as tree-node, type and formula information (although for presentational reasons, not all annotations are included in tree displays such as (1)). The tree-node address (Tn) allows each node in the tree to be uniquely identified (e.g. Tn(0) is the root node). The type value (Ty) of an expression at a given node includes the basic types Ty(t) (= proposition or ‘truth-value’; a sentence), Ty(e) (= entity; DP), and Ty(cn) (= common noun) and complex types such as Ty(e → t) (= predicate, a function from entities to propositions; verbs and adjectives). Finally, formula values (Fo) represent the conceptual-semantic content of a node. Note that the tree is not a syntactic tree, as it does not reflect word-order, but a representation of the semantic content associated with the utterance. The syntax part of Dynamic Syntax becomes relevant when talking about how these semantic representations are built in context, and it is in this sense that Dynamic Syntax is ‘dynamic’. The following steps of derivation for the string *John likes Mary* illustrate this.¹

¹ Analyses in this paper are simplified, especially with respect to formal aspects, partly due to reasons of space, and partly as I am more concerned with conceptual aspects of the model. Fuller details and explanations of formal concepts and notations can be found in the references cited.

Each Dynamic Syntax derivation begins with a simple tree with only one node as the starting point. The node is associated with the requirement, indicated by ‘?’, to derive an expression of $Ty(t)$, reflecting the hearer’s expectation to derive a proposition which can enter more general reasoning processes (2). This minimal tree will be expanded in the course of the derivation by a set of optional general transition rules (which I will not discuss in detail here) and lexical information, until a complete tree is derived, without any outstanding requirements.

(2) $Tn(0), ?Ty(t), \diamond$

The task to build an expression of $Ty(t)$ can be broken up into smaller subtasks, provided that the overall task will be fulfilled at some later stage in the parsing process. Here, a transition to the partial tree in (3) is licensed, which breaks down the overall tasks into two subtasks, and anticipates the introduction of the subject. The diamond symbol indicates the ‘pointer’, marking the current node in the parse:

(3)

$$\begin{array}{c} Tn(0), ?Ty(t) \\ \swarrow \quad \searrow \\ ?Ty(e), \diamond \quad ?Ty(e \rightarrow t) \end{array}$$

At this stage the lexical information from *John*, the subject of the sentence, can be scanned and entered into the derivation. Lexical information in Dynamic Syntax is modelled as a set of procedural statements, instructing the hearer to use the information from the lexical entry to develop the parse further. In the case of the entry for *John*, the first statement makes sure that the current node (indicated by the pointer) has the appropriate requirement for a $Ty(e)$ expression. If this is the case, then the node can be annotated with content information (the formula value $Fo(john')$) and with type information ($Ty(e)$). If *John* is parsed at a stage when the pointer is not at a node with a requirement for a $Ty(e)$ expression, the parse is aborted. In this way, the interaction of the pointer and lexical information is used to encode word-order restrictions.

(4) Lexical information from *John*

	IF	$?Ty(e)$
<i>John</i>	THEN	$put(Ty(e), Fo(john'))$
	ELSE	abort

Through scanning of *John*, the subject node has been completed, and the predicate node can be developed, in anticipation of the verb:

(5) Parsing *John* ...

$$\begin{array}{c} Tn(0), ?Ty(t) \\ \swarrow \quad \searrow \\ Ty(e), Fo(john') \quad ?Ty(e \rightarrow t), \diamond \end{array}$$

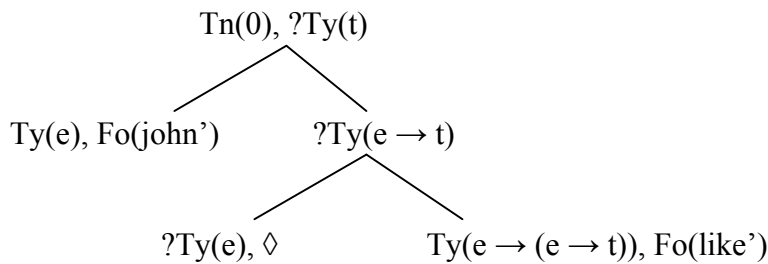
Lexical information from the verb can now be entered into the tree. Unlike the information from *John*, the lexical information from verbs like *like* not only decorates nodes, but also induces the building of further tree structure (agreement and tense information is ignored here for the moment). The lexical entry for *like* includes a number of modal and control statements which result in the construction of new tree nodes. These are in particular predicates like ‘make’, ‘go’ and ‘put’ which allow the annotation of different tree nodes and modal operators like $\langle \uparrow_1 \rangle$ (‘up a functor node’) or $\langle \downarrow_0 \rangle$ (‘down an argument node’):

(6) Lexical information from *like*

	IF	?Ty($e \rightarrow t$)
<i>like</i>	THEN	make($\langle \downarrow_1 \rangle$), go($\langle \downarrow_1 \rangle$), put(Ty($e \rightarrow (e \rightarrow t)$), Fo(like')),
		go($\langle \uparrow_1 \rangle$), make($\langle \downarrow_0 \rangle$), go($\langle \downarrow_0 \rangle$), put(?Tye)
	ELSE	abort

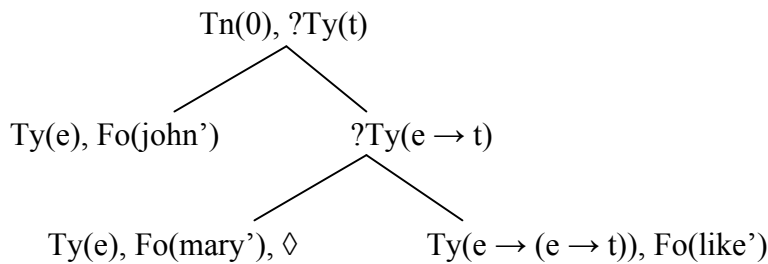
The use of the lexical information from *like* results in the partial tree in (7), with the pointer at the object node:

(7) Parsing *John likes ...*



After scanning the lexical entry for the transitive verb *like*, the tree has been expanded to include an object node as well as a node for the formula information from *like*. As noted above, the resulting tree structure is a representation of content, not a syntactic tree: there is no suggestion in (7) that English is a verb-final language. The verb’s lexical actions leave the pointer at the object node, and information from the object *Mary* can now be entered:

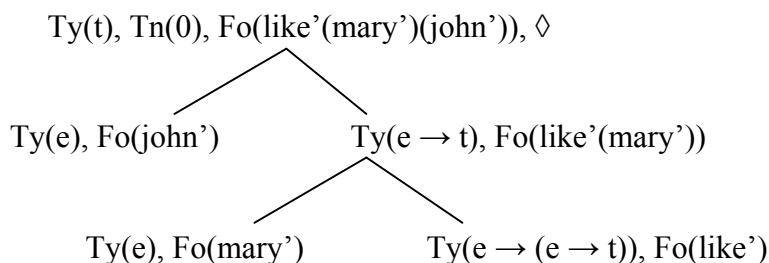
(8) Parsing *John likes Mary ...*



In the final step, the information accumulated during the parse can be assembled, and is compiled upwards through the tree, so that the initial requirement, to derive a

proposition at the root node, can be fulfilled. The derivation is well-formed if all requirements are fulfilled.

(9) Parsing *John likes Mary*



Although much more detail about the model could be given, this short example shows that in Dynamic Syntax, in contrast to most other syntactic models, syntax is seen as an incremental process, during which semantic trees are built step by step through a process of requirements and providing of information from lexical entries, reflecting the time-linear, left to right nature of natural language. In the following section, I show how the framework can be employed for syntactic puzzles in three African languages.

4. Case studies

In this section, I show how the Dynamic Syntax framework has been used for analysing three syntactic structures in African languages: Conjunction and agreement in Swahili, relative clauses in Bemba, and clause chaining and conjoining verbs in Hadiyya. Each case study also highlights a particular aspect of the Dynamic Syntax model: the Swahili case the importance of linear word-order, the Bemba case the interaction of phonology and syntax, and the Hadiyya case the concepts of underspecification employed in the system.

4.1. Word-order, conjunction and agreement in Swahili

Swahili has basic SVO word-order, but both subject-verb and verb-subject order are possible, expressing different information structure. Verbs agree with subjects and optionally with objects. The specific problem I discuss is verbal agreement with conjoined NPs (both subjects and objects), where sometimes the verb agrees with the full conjoined NP (full agreement), and sometimes only with one conjunct (partial agreement). Whether partial agreement is possible, depends on word-order: If the conjoined NP precedes the verb, only full agreement with a class 2 (human plural) subject marker is possible (10, 11), but if the conjoined NP follows the verb, either partial (with a class 1 human singular subject marker) or full agreement is possible (12, 13) (Marten 2005, Cann et al. 2005):²

- (10) Haroub na Nayla wa-li-kuja
Haroub CONJ *Nayla* SM2-PAST-come
 'Haroub and/with Nayla came'

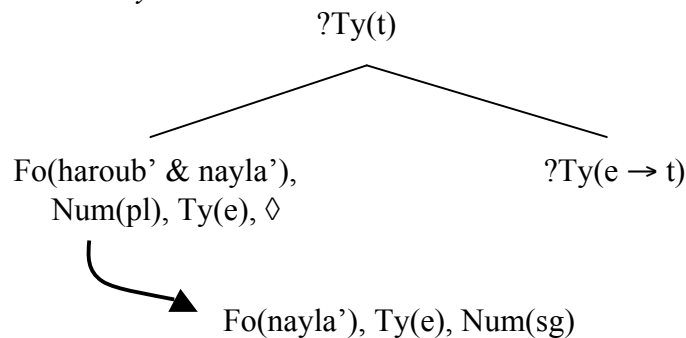
² Agreement with non-animate conjoined NPs is more complex, but I leave this to one side here. I will also not address 'second conjunct agreement', where the verb agrees with the second conjunct, but see Marten (2003) for discussion of examples like this in Luguru.

- (11) *Haroub na Nayla a-li-kuja
Haroub CONJ *Nayla* SM1-PAST-come
- (12) A-li-kuja Haroub na Nayla
 SM1-PAST-come *Haroub* CONJ *Nayla*
 ‘Haroub and/with Nayla came’
- (13) Wa-li-kuja Haroub na Nayla
 SM2-PAST-come *Haroub* CONJ *Nayla*
 ‘Haroub and/with Nayla came’

As the data show, singular agreement (with the first conjunct) is possible if the conjoined NP *follows* the verb (12), but not if it *precedes* it (11). The Dynamic Syntax analysis is based on the fact that in subject-verb order, the representation of the conjoined NP has *already been built* when the verb is encountered. In contrast, in verb-subject order, the first conjunct (*Haroub*) can fulfil the agreement requirement of the verb, and the conjunction is *built after the requirement has been fulfilled*. Notions like ‘before’ and ‘after’ can only be expressed in a framework like Dynamic Syntax, which encodes the linear order of natural language directly.³ The following snapshots illustrate the analysis.

In subject-verb order, information from the conjoined subject NP feeds into the structure building process first, starting with the first conjunct. I assume that the conjunction *na* projects a so-called LINK structure, that is, a part of the tree which is not related to the remainder of the tree in a predicate-argument relation, and which is semantically interpreted as conjunction (represented by an arrow in (14)). The complete formula value of the conjoined NP is represented at the subject node as $\text{Fo}(\text{haroub}' \ \& \ \text{nayla}')$, which is an expression of $\text{Ty}(\text{e})$. I also assume here a simplified representation of number, where nouns are annotated with number features, so that both *Haroub* and *Nayla* are $\text{Num}(\text{sg})$, but that the conjunction of the two becomes $\text{Num}(\text{pl})$:

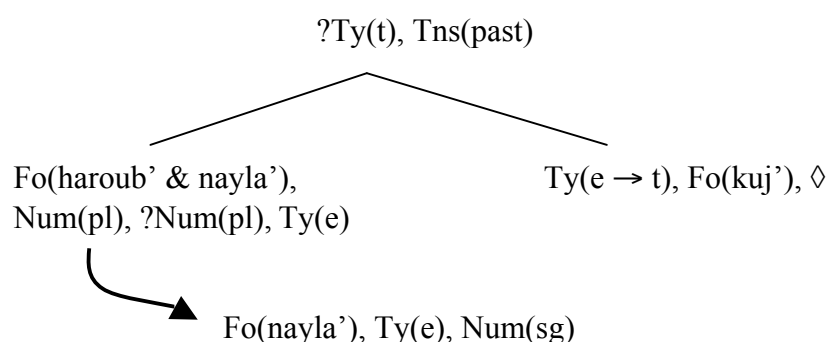
- (14) Haroub na Nayla ...
Haroub and Nayla ...



³ A variety of analyses for partial agreement have been proposed (e.g. Aoun et al. 1994, Johannessen 1998), including analyses for Bantu languages (e.g. Riedel 2009). However, they all involve either postulating two different structures for conjoined NPs, or two different analyses of the agreement relation, without fully capturing the essential quality of the data.

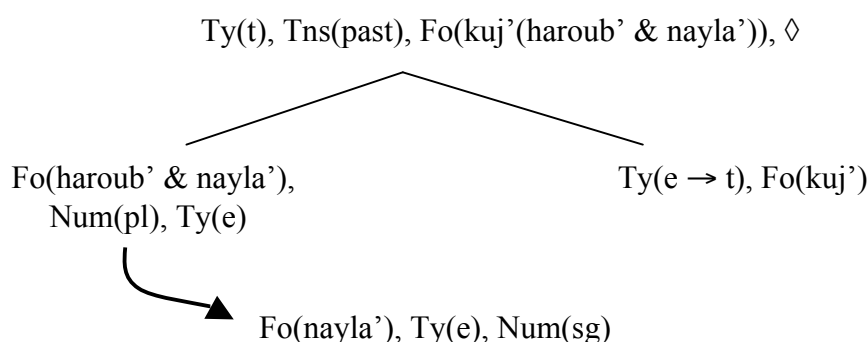
The next step in the derivation is the parsing of *wa-li-kuj-a*, ‘they came’. I simplify this here, since I assume the verb is parsed as one unit when in fact each morpheme makes its own distinct contribution to the development of the parse, and I ignore the contribution of the subject agreement marker for structure building (for a more detailed analysis, see e.g. Cann et al. 2005, Marten and Kempson 2002, Marten et al. 2008, Marten 2011). However, the main point here is that the verb with the plural (class 2) subject concord *wa-* induces a requirement that subject node be filled with an element with the feature Num(pl) (indicated as ?Num(pl) holding at the subject node), which is in this case immediately fulfilled, since the conjoined NP subject *Haroub na Nayla* projects this value, as noted above.

- (15) Haroub na Nayla wa-li-kuj-a ...
Haroub and Nayla SM2-PAST-come-FV ...



The final tree of the derivation is given in (16). All requirements are fulfilled (there are no more question marks in the tree), and the semantic formula at the top node designates the proposition that Haroub and Nayla came.

- (16) Haroub na Nayla wa-li-kuj-a.
Haroub and Nayla SM2-PAST-come-FV.

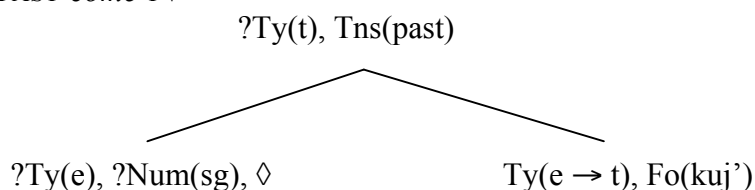


So far, the important point to note is that in subject-verb order, the verb has to show plural agreement, since, in this analysis, at the time the verb is introduced, the representation of the conjoined NP in subject position has already been built, and furthermore includes the plural value Num(pl). Hence, in this case, singular agreement is ungrammatical (11, above).

However, when the conjoined NP follows the verb, either full or partial agreement is possible. According to the Dynamic Syntax analysis, this is because the verb is introduced first and encodes, as in the previous case, a requirement on the subject position. However, since the subject has not yet been built, there is a stage in the derivation where the representation of the first conjunct of the subject is the only element annotating the subject node, and can fulfil the requirement of the verb (partial agreement). On the other hand, the requirement can also be fulfilled after the whole of the conjoined NP has been parsed, resulting in full plural agreement. Again, the following snapshots show this.

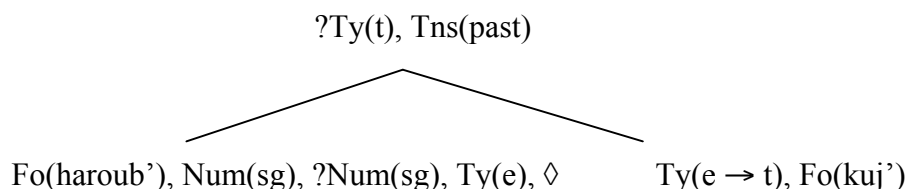
In verb-subject order, the verb *a-li-kuj-a* is the first element to be parsed into the tree, resulting in the annotation of the right-hand side branch of the partial tree with the formula and type value. The node on the left-hand side branch, the subject position, is annotated with the requirement for an expression with Num(sg), as the verb has the subject marker *a-* for 3rd person human singular (or class 1). Apart from this difference, these are exactly the same actions which were induced by the verb in the preceding example, but they are performed before the subject node has been annotated with any information.

- (17) A-li-kuj-a ...
SM1-PAST-come-FV



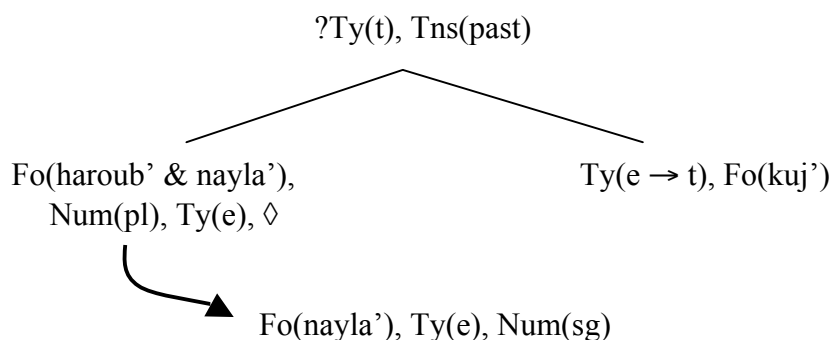
At this stage, the subject can be built. The first conjunct of the conjoined subject is *Haroub*, and information from *Haroub* is duly entered at the subject position. Note that *Haroub* is a singular expression and hence projects an annotation Num(sg) at the subject node. It is this annotation from *Haroub* which fulfils the singular requirement of the (singular) verb:

- (18) A-li-kuj-a Haroub...
SM1-PAST-come-FV *Haroub*...



After this stage, the tree develops as in the previous example, by building the LINK structure induced by the conjunction *na* and the building of the second conjunct. The final value of the conjoined subject is Num(pl), as in the preceding example, but the important point is that the requirement of the verb has already been fulfilled by the first conjunct.

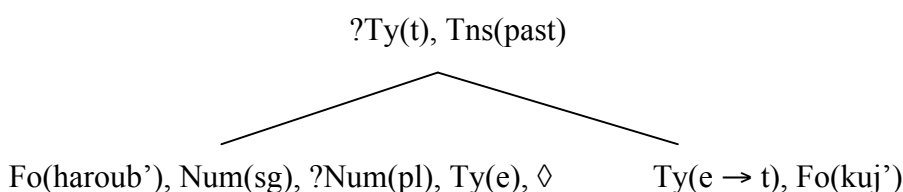
- (19) A-li-kuj-a Haroub na Nayla ...
 SM1-PAST-come-FV *Haroub and Nayla ...*



The final tree of this derivation is in fact identical to the final tree of the previous derivation (16, above). The claim is that in terms of (truth-conditional) semantics all our example sentences are identical, but that they differ in the way they are constructed, in the way they interact with context and hence in information structure.

The final example (13) is analysed in principle in the same way as the previous one. The verb is built first, and enters a requirement at the subject position, but this time for a plural expression. This requirement cannot be fulfilled by the first conjunct, as it was in the last example, and thus remains unfulfilled until after the conjunction has been built.

- (20) Wa-li-kuj-a Haroub...
 SM2-PAST-come-FV *Haroub...*



However, after the building of the conjunction, the requirement can be fulfilled, as the conjunction is a plural object, even though each member is singular. The plural requirement from the verb is thus fulfilled later than the singular requirement in the corresponding parse, but in both cases, the requirements from the verb are fulfilled before the completion of the parse. In all cases discussed here, the final resulting semantic tree is the same:

- (21) $Ty(t), Tns(past), Fo(kuj'(haroub' \& nayla')), \diamond$
-
- A semantic tree diagram for the sentence (21). The root node is $Ty(t), Tns(past), Fo(kuj'(haroub' \& nayla')), \diamond$. It branches into two children: $Fo(haroub' \& nayla'), Num(pl), Ty(e)$ on the left and $Ty(e \rightarrow t), Fo(kuj')$ on the right. A curved arrow points from the left child to a new node $Fo(nayla'), Ty(e), Num(sg)$.

However, all examples differ in the way in which this final tree is derived. The analysis thus claims that the relation between word-order and agreement can be explained by the dynamics of parsing, that is, the way hearers construct semantic representations on-line. In contrast to other frameworks, the Dynamic Syntax analysis puts the main explanatory burden on the interaction of structure-building processes and word-order. This approach is confirmed by further evidence from object marking. The possibilities of partial and full agreement are related to word-order in the same way as we have seen above:

- (22) Amina a-li-wa-ona Haroub na Nayla
Amina SM1-PAST-OM2-see Haroub CONJ Nayla
 ‘Amina saw Haroub and/with Nayla’

- (23) Amina a-li-mw-ona Haroub na Nayla
Amina SM1-PAST-OM1-see Haroub CONJ Nayla
 ‘Amina saw Haroub and/with Nayla’

- (24) Haroub na Nayla, Amina a-li-wa-ona
Haroub CONJ Nayla Amina SM1-PAST-OM2-see
 ‘Haroub and/with Nayla, Amina saw them’

- (25) *Haroub na Nayla, Amina a-li-mw-ona
Haroub CONJ Nayla Amina SM1-PAST-OM1-see

The examples show that post-verbal conjoined objects can show either full or partial agreement. However, when the conjoined object is fronted, and hence precedes the verb, only full agreement is possible. This confirms the view that that it is linear surface order which is involved, and not differences in the structure of coordination or of subject-predicate relations.

Before concluding some short further remarks are in order. As mentioned before in passing, the different word-order and agreement patterns are associated with different information structure. Without going into details, verb-subject order is often associated with new information focus on the subject. This is not expressed clearly in the simplified analysis above, but is discussed in more detail in Marten (2007, 2011). Furthermore, singular agreement in verb-subject structures restricts focus to the first conjunct, which from a Dynamic Syntax perspective can be seen as a direct function of the order in which the proposition and the conjunction are built. A related construction which I have not discussed here, but to which the analysis could be extended is the ‘extraposition’ structure below:

- (26) Haroub a-li-kuja na Nayla
Haroub SM1-PAST-come CONJ Nayla
 ‘Haroub came and/with Nayla’

Here, the LINK structure is built only after the proposition has been constructed, and thus singular agreement is necessary. Finally, agreement with conjoined NPs differs between different Bantu languages. Many languages do not allow partial agreement at all (e.g. Herero), while others like Luguru seem to use the system more productively to

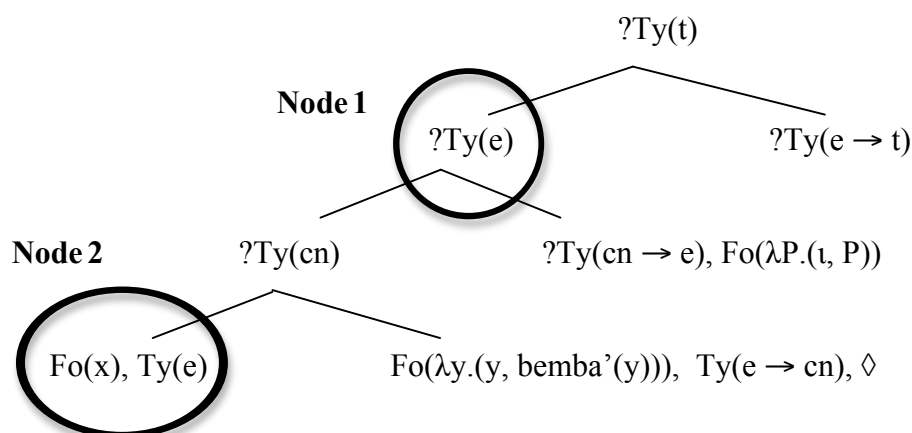
express information structure (Marten 2003). However, my aim here was merely to show how the Swahili pattern can be explained from a hearer-based perspective as adopted in Dynamic Syntax.

4.2. Relative clauses in Bemba and the phonology-syntax interface

The second case study comes from Bemba and addresses the question of the interaction between syntax (in our dynamic sense) and phonology. In Bemba, head nouns of restrictive and non-restrictive relative clauses are prosodically (tonally) distinguished (Cheng and Kula 2006, Kula 2007), and I show how this can be seen as a parsing device aiding the establishment of the proposition expressed following Kula and Marten (2011).

Relative clauses are analysed in Dynamic Syntax as a conjunction of two clauses with a shared term. Formally, this is expressed through a LINK structure, already encountered in the previous section, built from a $Ty(e)$ node to a new $?Ty(t)$ node. Furthermore, NPs are analysed as complex terms including nodes to express quantification and restriction. The LINK relation introducing the relative clause can be launched from either of two $Ty(e)$ nodes present in a complex NP: from the $Ty(e)$ node representing the head-noun (Node 1, below), or from the $Ty(e)$ node which introduces a nominal variable which is restricted (minimally) by the common noun (Node 2):

(27) NP structure and possible nodes for launching a LINK structure



The two alternative nodes from which a LINK structure may be launched are freely available, and the choice depends on the stage in the derivation at which the LINK relation is launched: either when the nominal variable (Node 2) is introduced, so that the LINK relation modifies/restricts the variable, resulting in a restrictive reading, or after the semantic representation of the head noun has already been completed, so that the LINK relation is launched from the $Ty(e)$ node representing the full, completed information from the head noun (Node 1), resulting in non-restrictive reading.

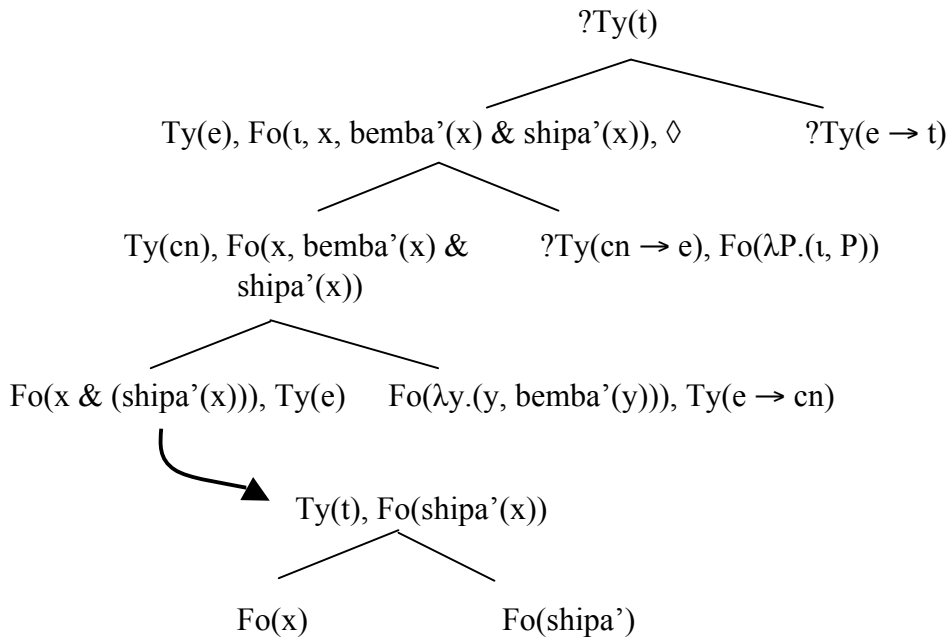
In Bemba, this difference is marked prosodically through ‘conjoint’ and ‘disjoint’ tone patterns of the head noun of the relative (Sharman 1956). Conjoint tone pattern, with a final H tone on the head noun, indicates restrictive reading, that is, it selects a sub-set of the individuals identified by the head-noun (28). In contrast, disjoint tone pattern indicates non-restrictive reading, that is, it merely adds information about a set of

individuals already established by the information from the head noun (29) (Kula 2007, Kula and Marten 2011):

- (28) Abá-Bembá ábá-shipa ba-ikala mu-Zambia
2-Bemba SM2REL-brave SM2-live 18-Zambia
'The Bembas who are brave live in Zambia' (and those who are not live abroad)
- (29) Abá-Bemba ábá-shipa ba-ikala mu-Zambia
2-Bemba SM2REL-brave SM2-live 18-Zambia
'The Bembas, who are brave, live in Zambia' (all Bembas are brave and live in Zambia)

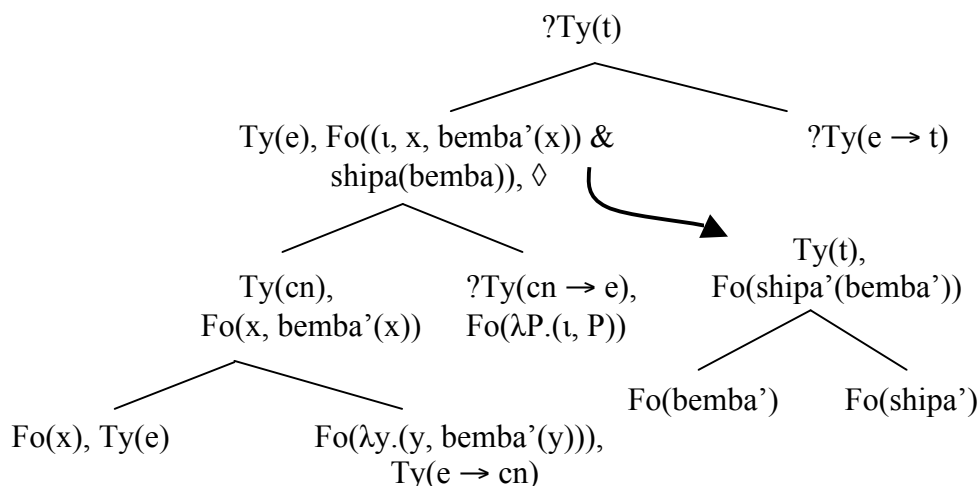
In Dynamic Syntax terms, this means that conjoint tone indicates that the semantic representation of the head-noun is not complete after the head noun is parsed, and that further lexical information needs to be taken into account. After parsing the head noun, further information is thus required, and this is provided by the following relative clause. Formally, this means that a LINK relation is projected and built immediately when the variable node (Node 2, above) is built to ensure that the information from the relative clause becomes part of the restriction of the interpretation of the noun phrase. The information from the relative clause is projected onto the LINK structure, and can then be projected upwards to restrict the interpretation of the head noun (30):

(30) Restrictive relative



In contrast, disjoint tone means that the LINK relation has to be built after the semantic value of the head noun has been computed. Information from the relative clause provides additional information about the head noun, but does not contribute to its semantic delimitation. Thus the LINK relation is launched from the Ty(e) node of the head noun (Node 1, above) as in (31):

(31) Non-restrictive relative



In this case, the relevant information for the establishment of the representation of the head-noun has already been assembled, and the LINK relation provides additional information.

From a more theoretical point of view, what is interesting about these data is the window they open on the interaction between syntax and phonology. One of the questions in this area is to what extent these two ‘modules’ interact, or are independent of each other. From our perspective, relative marking in Bemba can be seen as supporting a conception in which phonology contributes to parsing. In this particular case, the tonal marking of the head-noun indicates whether the construction of the semantic representation of the head-noun can be achieved with the lexical (and contextual) information available when the head noun is parsed (disjoint pattern), or whether further lexical information (from the relative clause) is needed for the construction of this interpretation (conjoint pattern). Interestingly, a similar contrast between conjoint and disjoint tone patterns is also found with verbs (in fact, this case is better described than the nominal case), thus supporting the view that the contribution of phonology to structure building is independent of the particular lexical category it is associated with. In conclusion, the evidence presented here supports a conception of the phonology-syntax interface in which prosodic information directly interacts with parsing on-line choices, so that the phonology-syntax interface is unidirectional, and serves as an aid in the establishment of semantic structure.

4.3. Underspecification, temporal dependencies and clause chaining in Hadiyya

The final case study comes from Hadiyya, a Highland East Cushitic (Afro-Asiatic) language (data from Hosiana) and is based on Perrett (2000). It offers the opportunity to introduce another key aspect of Dynamic Syntax, namely structural underspecification. So far, I have tacitly assumed that lexical information is presented approximately in the order in which it is used to build the relevant structural part of the tree. However, word-order variation within one language or cross-linguistically shows that this assumption is too naïve. Since the Dynamic Syntax model is set up to model the on-line processing of natural language input on a left-to-right basis, information once encountered has to be used, and cannot be changed or cancelled later. One way to express word-order variation within the framework without ‘undoing’ information is by using a concept of

structural underspecification. This means that information is parsed, but not fully determined until more information becomes available at a later stage. The particular data I am going to use in this section are a type of so-called conjoining verbs, which are underspecified both with respect to interpretation of the subject, and with respect to temporal interpretation.

Hadiyya is a verb-final language with clause chaining constructions and has three types of conjoining verbs (CV): CV0 with full person marking, and where the subject can be freely constructed, CV1 which usually shows no person marking, and CV2 with full person marking, which is almost always followed by change in subject (switch-reference). Temporal information is often only found at the last verb of the chain; conjoining verbs encode (expletive) dependency with tense information supplied by the final verb. The following examples show conjoining verb 2 (32) and conjoining verb 1 (33):

- (32) Gaaw wo?-o agis-u-kk-aare oo luww hund-im
 hookah *water*-ABS *drink_cause*-PERF-3M-CV2 *that* *thing* *all*-CONJ

ka k'amacco-nne he?-u-kk-o
 this *ape*-LOC *be*-PERF-3M-IND

'He made (them) drink hookah water and all that thing was on the ape.'

(adapted from Perrett 2000: 170)

- (33) k'amacc hakk'-a iik'-aa waar-aa u?luma-nne
 ape-NOM *wood*-ABS *break*-CV1 *come*-CV1 *doorway*-LOC

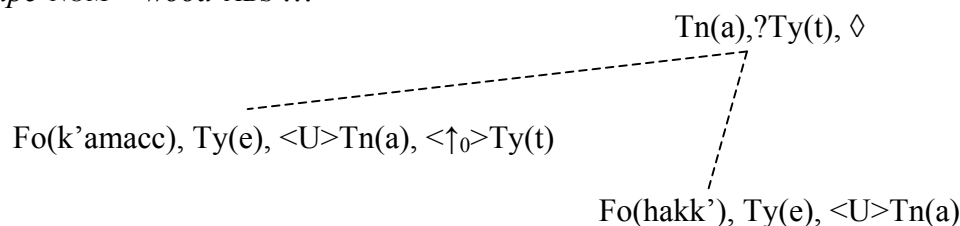
diss-aa min-e aag-u-kk-o
 put-CV1 *house*-ABS *enter*-PERF-3M-IND

'The ape broke the wood, came, put it on the doorstep and entered the house.'

(adapted from Perrett 2000: 151)

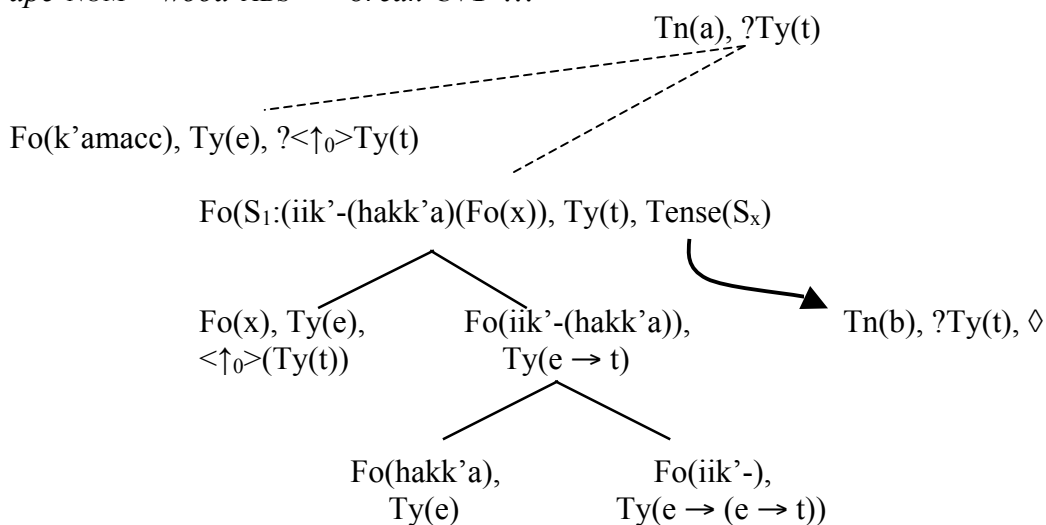
Although much more could be said about these examples, I am concentrating here on (33) and the conjoining verbs (CV1) in it. The first task is to provide an appropriate structure for the two initial NPs in (33). Since the order of NPs is quite free, their role is encoded in the case marking, and furthermore, since at the outset of the parse, it is not known whether multiple clauses will be parsed, and if so, to which clause the initial NPs belong, their initial structural position has to be quite weak. They are thus attached at structurally underspecified, unfixed nodes (indicated by the broken line), with the only constraint that their eventual position be somewhere below the root node: <U>Tn(a) indicates that the root node Tn(a) needs to be somewhere up ('U'). In addition, the information from the nominative case marker projects a requirement <↑₀

- (34) k'amacc hakk'-a ...
ape-NOM wood-ABS ...



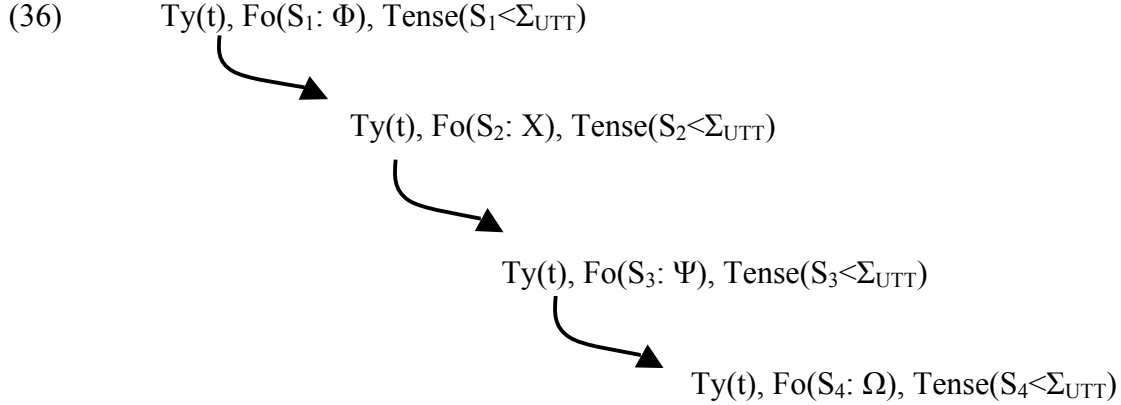
The CV1 morphology *-aa* of the following two verbs supplies an expletive subject, that is, it provides a lexically underspecified formula value which allows the parse to proceed while at the same time the interpretation of the subject, and of the tense value of the propositional node can be delayed. Lexically, CV1 verbs supply three types of information: 1) a subject node with an expletive variable as placeholder ($Fo(x)$, $Ty(e)$); 2) a distinct expletive temporal label, which will be fully evaluated only when the tense information from the final verb is parsed ($Tense(S_x)$); and 3) the requirement for a LINK relation, to conjoin this and the following clause – shown in (35) as a LINK relation to a new root node ($Tn(b)$, $?Ty(t)$). This gives the following partial tree:

- (35) k'amacc hakk'a iik'-aa ...
ape-NOM wood-ABS break-CV1 ...



As the tree shows, clauses with CV1 verbs build partially fixed (sub-)trees with underspecified subject and tense information. Since after the parsing of the verb, the pointer moves back to the root node, the process can be repeated, with increasingly more underspecified structure being added, so that clause-chaining becomes an iterative process. It is only when the final verb is parsed, that complete information about the subject of the conjoining verbs and about the temporal interpretations becomes available, which is then used to provide an interpretation for all expletive nominal and temporal elements in the clause chain. In the case of (33), the final clause with the inflected verb *aag-u-kk-o* 'enter-PERF-3m-IND' supplies the temporal value (from the perfect marker *-u*) which is copied into all preceding tense variables. The person agreement *-kk* '3ms' annotates the subject node of the final clause with ($Fo(U_{pro}$, 3ms), which can be (pragmatically) interpreted as $Fo(k'amacc)$, which is given in the context, and all

instances of expletive subjects will be replaced by the final clause subject. The final *-o* vowel indicates that the full string has been scanned so all outstanding requirements will have to be fulfilled once the *-o* is parsed. The final representation, omitting the full tree structures, is a dependent structure of four propositional formulas LINKed to each other:



The establishment of the final structure involved several instances of structural and lexical underspecification. The initial position of the $Ty(e)$ expressions was underspecified vis-à-vis their eventual position, and the morphology of the conjoining verbs was analysed as encoding both nominal underspecification for the subject position, and temporal underspecification for the temporal interpretation of the event. All in all, this provided a complex example of expletive elements and their eventual resolution. However, the structural tools used in the analysis are actually not that complex, and not restricted to verb-final languages or clause chaining. Unfixed nodes are used for the analysis of left and right dislocation (see Cann et al. 2005), type variables are used to model expletive pronouns found in different languages (e.g. Marten 2011), and are here extended to temporal underspecification. Thus, the tools employed here for the analysis of Hadiyya clause chaining are universal, even though they combine to result in a language specific pattern of the sharing of information in this particular case.

5. Conclusions

In this paper, I have provided a brief outline of the syntactic model of Dynamic Syntax and shown how it works with reference to three short case studies. Dynamic Syntax models how hearers build semantic representations from words and context, on a left-to-right basis. The main conceptual claim of the model is that linguistic knowledge is a reflex of our ability to parse, and it is thus part of our more general cognitive ability to take partial and fragmented input and to develop it into fully specified semantic representations which enter general reasoning processes. Even though aspects of our knowledge of natural language are medium-specific, the general architecture is embedded closely into our general cognitive abilities.

The three case studies have shown in general how the model works, and some applications to African languages. Each case study has furthermore highlighted specific aspects of the model. The Swahili case provided support for the general Dynamic Syntax claim that linear surface order of words and constituents is an important aspect of syntactic explanation, which is often obscured in other, more hierarchical frameworks. The Bemba relative clauses furnished an illustration of how the interaction

between syntax and phonology could be modelled from the Dynamic Syntax perspective. The analysis shows that phonology interacts directly with syntax, and contributes information for the hearer as to how to construct the intended interpretation of the string. The final case study raised questions about word-order and word-order variation beyond the scope of this paper. However, the sketch of the analysis provided has shown how concepts of underspecification can be exploited to analyse verb-final syntax, and temporal underspecification as seen in clause chaining in Hadiyya. While all three case studies were necessarily abbreviated and not fully developed, they nevertheless provided some indication of the workings of Dynamic Syntax.

Like other theoretical models, Dynamic Syntax is a model of human language and makes claims about the cognitive architecture all humans as users of language share. Although there is, from this perspective, nothing particular about African languages, evidence from African languages provides important empirical data for the development of the Dynamic Syntax model. Quite generally, I hope to have shown that interaction between general-theoretical linguistics and African linguistics is important, as linguistic theories are only as good as the analysis they provide for specific language data, but also as specific research questions developed from a specific theoretical perspective lead to the discovery of new empirical data and helps to view new and old language data from a new perspective. Although it is quite unlikely that one particular (formal or other) framework will provide answers to all the questions which are relevant for understanding human language, through interaction between different theoretical approaches and detailed description of African languages our understanding of natural language can be furthered.

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